National Park Service
U.S. Department of the Interior

Crater Lake National Park

Whitebark Pine Conservation Program

2015 Annual Report

ON THIS PAGE
Whitebark pine collection tree GP01 on the summit of Garfield Peak.
Photograph by J. Beck.

ON THE COVER
Whitebark pines on Dutton Ridge.
Photograph by J. Beck.

Whitebark Pine Conservation Program

2015 Annual Report

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December 2015

U.S. Department of the Interior
National Park Service
Crater Lake National Park
Crater Lake, Oregon

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Please cite this publication as:

Beck, J.S. 2015. Whitebark Pine Conservation Program 2015 Annual Report. Crater Lake National Park, Crater Lake, Oregon.

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Abstract

Major activities of Crater Lake National Park's Whitebark Pine Conservation Program in 2015 supported the Park's goals and objectives for conserving and restoring whitebark pine. Annual Collection tree monitoring detected two new mortalities of Collection trees, no new white pine blister rust infection, three new mountain pine beetle attacks, and one new dwarf mistletoe infection. One hundred eighty-one trees of management importance were treated with verbenone to help ward off attack by the mountain pine beetle. Due to a dearth of whitebark pine cones Park-wide, no new cone collections were made in 2015 but the presence of late-summer conelets indicates cone collection will again be possible in 2016. Results from the Park's long-term monitoring plots indicate that whitebark pine is continuing its decline within plot areas, as mature whitebark pine have been reduced by 28.3% from 2003 – 2015. The leading mortality agent of whitebark pine within plot areas continues to be the mountain pine beetle. The Park's four whitebark pine restoration plantings were monitored with survival rates ranging from 73.4 – 87.9% three to six years after planting. Planning is underway for the Park's next whitebark pine restoration outplanting, scheduled for 2016.

Acknowledgments

The Crater Lake National Park Whitebark Pine Conservation Program received assistance this year with verbenone application to large-diameter “legacy” whitebark pines from the United States Forest Service (USFS) Forest Health Protection (FHP) program and local FHP Entomologist Andy Eglitis. The USFS Dorena Genetic Resource Center continued to assist the Park with blister rust resistance screening, growing whitebark pine seedlings for restoration, and monitoring the Park’s whitebark pine restoration plantings. Local FHP Plant Pathologist Brent Oblinger assisted with dwarf mistletoe species identification and assisted with sampling the Park’s whitebark pine long-term monitoring plot on Wizard Island.

Introduction

Whitebark pine (*Pinus albicaulis* Engelm.) is a hardy, long-lived species that tolerates the severe conditions found at the highest elevations of Crater Lake National Park (CRLA). Whitebark pine is considered both a foundation and a keystone species due to the important role it plays in creating and sustaining high elevation vegetation communities (Tomback et al. 2014). The seedlings of whitebark pine can tolerate full sun and are able to establish in previously tree-less areas, earning it the reputation of a colonizing or pioneer species (Tomback et al. 2001). Once established, they ameliorate harsh site conditions and facilitate the establishment of a diverse suite of subalpine species. Whitebark pine stands serve important functional roles such as shading and retaining snowpack and thereby regulating snowmelt, and slowing erosion by anchoring soils in place. Whitebark pine shares a mutualistic, co-evolved relationship with the Clark's nutcracker (*Nucifraga columbiana*). Whitebark pine is considered a "stone pine" as it bears cones that remain closed at maturity and require animal assistance (typically from Clark's nutcrackers – but also from squirrels, bears, and other mammals) to open cones and extract seeds. The Clark's nutcracker stores whitebark pine seeds in "caches" for future use (Figure 1), relying on a complex spatial memory to enable it to retrieve seeds at a later date. Caches that are not utilized can develop into whitebark pine stands and woodlands.

Whitebark pine has been declining within the Park for decades. A non-native pathogen, *Cronartium ribicola*, that causes the disease white pine blister rust (WPBR), was introduced to western North America in 1910. Since that introduction, WPBR has spread throughout the range of whitebark pine with devastating results. Few whitebark pines have genetic resistance to WPBR, and the disease is progressive and fatal. Warming temperatures and milder winters at high elevations have facilitated a prolonged outbreak of the native mountain pine beetle (MPB – *Dendroctonus ponderosae*). At CRLA, MPB has surpassed WPBR as the leading mortality agent for whitebark pine (Smith et al. 2011). Projected suitable habitat for whitebark pine under different climate change scenarios declines steeply, especially in the Cascade Range (Warwell et al. 2007; Littell et al. 2013). In 2011, the United States Fish and

Figure 1. Newly emerged cache of whitebark pine seedlings with their seed coats still attached. Photo by J. Beck.

Wildlife Service determined that listing whitebark pine as a threatened or endangered species was warranted but precluded by higher priority work. Whitebark pine remains a Candidate species for listing under the Endangered Species Act.

In 2003, CRLA applied the first actions in what would become a Whitebark Pine Conservation Program (WPCP). The Terrestrial Ecology team began by implementing a whitebark pine long-term monitoring program and collecting cones from whitebark pines so that seedlings could be grown and tested for resistance to WPBR at the United States Forest Service (USFS) Dorena Genetic Resource Center (DGRC). Since then, CRLA's WPCP has expanded to include not only long-term monitoring and rust-resistance screening, but outplanting seedlings grown from rust-resistant "Parent" trees for restoration; applying verbenone, a bark beetle repellent, to whitebark pines hat have had their cones collected for rust-resistance screening (called "Collection Trees"); annual monitoring of rust-resistant trees; and conducting sanitation pruning of branches infected with dwarf mistletoe (*Arceuthobium cyanocarpum*) and WPBR. This report summarizes major activities of the WPCP in 2015 including: (1) Collection tree monitoring, (2) verbenone application; (3) CRLA's long-term whitebark pine monitoring, and (4) monitoring of the Park's four whitebark pine restoration plantings.

Figure 2. Whitebark pine pollen cone crop on Garfield Peak in late June 2015. Photo by J. Beck.

Collecting cones from new phenotypically rust-resistant whitebark pines was suspended in 2015 due to a cone crop failure. Very few cones were observed Park-wide in 2015. However, a healthy pollen cone crop was observed in 2015 (Figure 2) and conelets were observed in most areas by late summer 2015. The 2016 season should again bring a healthy whitebark pine cone crop to the Park; although it does not appear a mast year will occur.

Since many aspects of whitebark pine biology and health (e.g., seedling mortality and survival; tree vigor; length of growing season) are affected by annual climactic trends, it is important to note that the 2015 season marked the third consecutive summer the Park and region suffered through a drought. The Park received only 197" of snow at Park headquarters (average is 524") during the 2014—2015 water year (October 1 – September 30), which is 38% of average (Figure 3). However, the total amount of precipitation (melted) received at Park headquarters was closer to average at 61" (average is 67"), which is 91% of average. The warm 2014-2015 winter contributed to more precipitation falling as rain vs. snow at Park headquarters. Snowmelt occurred over a month earlier than average; with the first snow-free date at Park headquarters reached on May 11th (average date is June 20th).

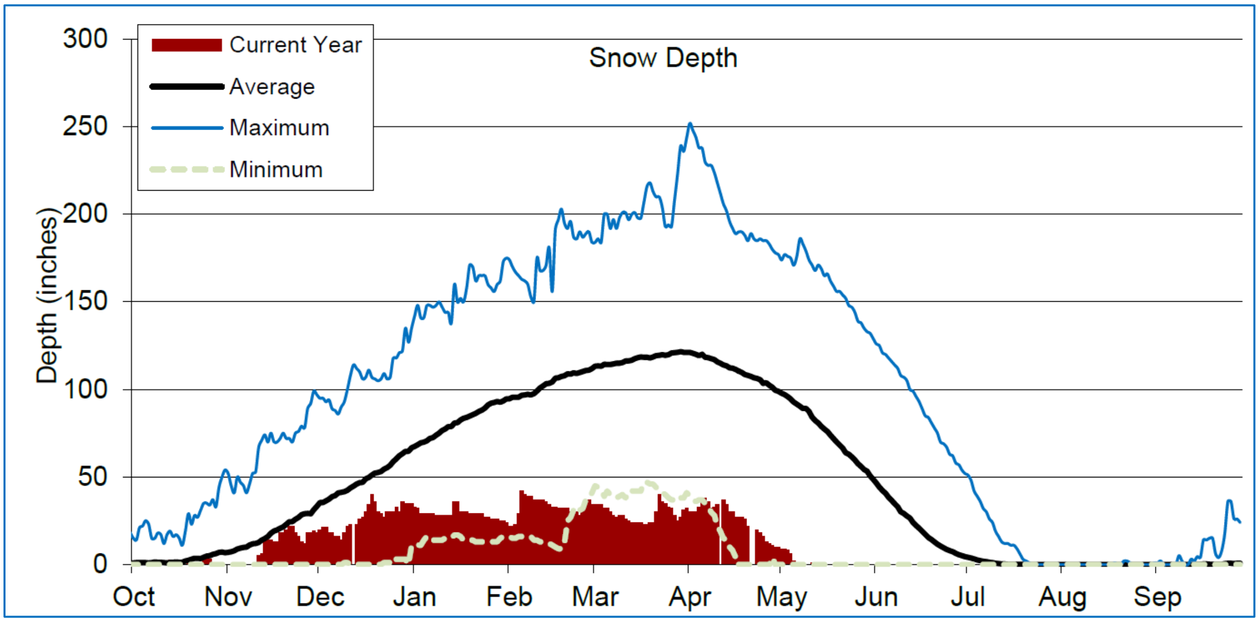

Figure 3. Snow depth data for the 2014-2015 water year, collected at Crater Lake National Park headquarters.

This year CRLA with the Whitebark Pine Ecosystem Foundation's (WPEF) Annual Science and Management Workshop held in Ashland, Oregon on September 17-20, 2015. This was the first time the WPEF held its annual meeting on the Pacific coast, and many efforts to study, conserve, and restore whitebark pine and other high-elevation five-needle pines in Oregon, Washington, and California were highlighted. The workshop featured field trips to the Crater Creek Research Natural Area in the Klamath National Forest to see whitebark pine and foxtail pine; Crater Lake National Park to see our whitebark pine; and the USFS DGRC to see rust-resistance screening efforts in action. The WPEF CRLA field trip showcased the WPCP, with stops featuring the Rim Village whitebark pine restoration planting site, blister rust impacts to whitebark pine stands on Watchman Peak; dwarf mistletoe impacts to whitebark pine at Grotto Cove; and mountain pine beetle impacts to whitebark pine at Dutton Ridge.

Methods

Methods are discussed separately for each of the four major components of the 2015 WPCP.

Collection Tree Monitoring

The DGRC has been assisting CRLA with identifying rust-resistant whitebark pines since 2003. Cones from CRLA whitebark pines are harvested and sent to the DGRC, which then extracts and stratifies seeds and grows seedlings for rust-resistance trials and/or for restoration. The rust-resistance screening process currently takes seven years to complete; two-year-old seedlings are inoculated with *C. ribicola* at the DGRC, monitored for five years, and then assigned a resistance rating of A-F (much like grades in school) with "A" showing the most resistance and "F" the least. All CRLA whitebark pines that have had cones collected and sent to the DGRC for rust-resistance screening are called "Collection" trees. Collection trees are given a rating of A-F based on the rust-resistance of their progeny. Trees that receive A-C rust-resistance ratings are deemed "Resistant" trees. Trees that receive "D" and "F" ratings are "Susceptible" trees; and trees whose progeny are currently undergoing rust-resistance screening trials are called "Candidate" trees. While the most rust-resistant trees are considered "A" and "B" trees, "C" trees are considered moderately resistant and included in the definition of Resistant trees to include more genetic diversity for restoration purposes. All Resistant and Candidate trees are monitored on an annual basis, and in 2015 all Collection trees were monitored to assess status of Susceptible trees, as well.

Annual Collection Tree Monitoring entails assessment for WPBR, MPB, dwarf mistletoe, or other damage; assessing the cone crop; and photographing the tree and any notable features (e.g., cankers). Parameters such as diameter at breast height (DBH), tree height, assessment of non-whitebark pine conifer competitors, and spatial coordinates are updated every five years. A complete account of the Collection Tree Monitoring program is available in the Crater Lake National Park Whitebark Pine Conservation Plan (Beck and Holm 2014). Typically verbenone application to Resistant and Candidate trees occurs concurrently with Collection Tree Monitoring.

Verbenone Application

The MPB utilizes a group attack strategy to kill a host tree (Figure 4). When a female beetle finds a suitable host, she emits an aggregating pheromone that invites other beetles to colonize the host. Conversely, when the host tree has been fully colonized, beetles produce an anti-aggregating pheromone to signal to other beetles that the host is fully occupied. Verbenone is a synthetic form of the anti-aggregating pheromone, and it has been applied as a bark beetle repellent to high-value whitebark pines at CRLA since 2004. Presently, CRLA staples two 7g pouches to the north side of the bole as high up as the applicator can reach while spacing the pouches at least one vertical foot apart. Trees with DBH > 100 cm often have four verbenone pouches attached when supplies allow. Verbenone is applied annually in June (often July for new Collection trees when cones are caged) to all living Resistant and Candidate trees with the exception of trees with DBH < 15 cm DBH. Pouches remain attached until the following

Figure 4. Mass-attack strategy of the MPB. Photo by J. Beck.

June, when they are removed and replaced with fresh pouches.

Since many Collection trees are found in high visitor-use areas (near trails, pullouts, overlooks, etc.), a small laminated note is attached with the pouches alerting Park visitors of the pouches' purpose and warns them to not touch the pouches. In years with low verbenone supplies due to budgetary constraints, "C" rated Resistant trees may not be treated. The full CRLA Verbenone Treatment Plan is available in the Park's Whitebark Pine Conservation Plan (Beck and Holm 2014).

Due to the ongoing MPB outbreak at high elevations, assistance was received from the USFS Forest Health Protection (FHP) program to treat large-diameter "legacy" whitebark pines with verbenone (Figure 5). Verbenone was applied to these legacy whitebark pines in the areas suffering the highest levels of MPB activity along East Rim Drive from Scott Bluffs to Dutton Ridge as determined by ocular surveys. Legacy trees were identified by surveying an area impacted by recent MPB activity and seeking out large-diameter trees that appeared to be good cone producers and/or very old based on their diameters. Most legacy trees received two 7 g pouches of verbenone, but very large (> 100 cm DBH) diameter trees received four pouches.

Long-Term Whitebark Pine Monitoring

Crater Lake National Park implemented a long-term monitoring program in 2003 to track changes in whitebark pine communities. Seven plots were strategically placed in areas representing different whitebark pine vegetation types throughout the Park (Figure 5). With the exception of 2008, plots have been sampled annually since 2003. These plots track changes in tree health and density, understory vegetation cover, and substrate cover. Tree data are collected annually (with the exception of data on DBH, tree height, and canopy position, which are collected every five years); understory vegetation data are collected every other year; and substrate cover data are collected every five years. Parameters collected annually on individual trees include tree health, blister rust infection and presence of active and inactive cankers, MPB attack and severity, presence of cones, presence of mammal damage (e.g., gnawing) and severity, and any additional damage (e.g., chlorosis, mechanical damage) that may have affected the tree. Understory vegetation and substrate data are collected using a relevé approach encompassing the entire plot. In 2015, plots were sampled from August 24 – September 8.

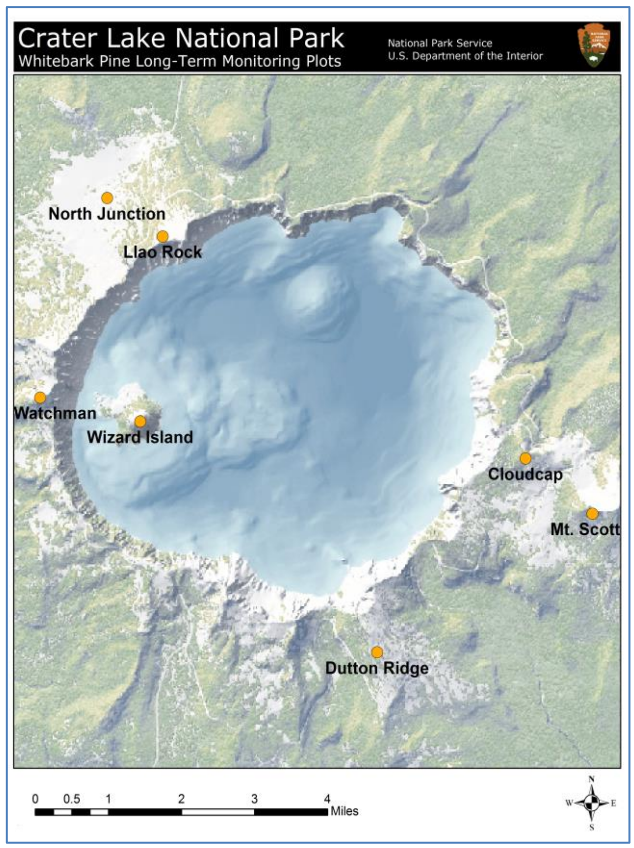

Figure 5. Locations of CRLA's long-term whitebark pine monitoring plots. Map by J. Beck.

This Park-based long-term monitoring effort is separate from and complementary to the Vital Sign long-term monitoring of whitebark pine implemented in 2012 by the National Park Service (NPS) Klamath Inventory and Monitoring Network (KLMN). The KLMN effort established 30 whitebark pine long-term monitoring plots throughout the Park utilizing a peer-reviewed protocol employed by several NPS units in the Pacific West region. Information on this effort is available here: http://science.nature.nps.gov/im/units/klmn/monitor/whitebark.cfm

Whitebark Pine Restoration Plantings

Four whitebark pine restoration plantings have occurred at CRLA: the 2009 Rim Village, 2009 Horse Trail, 2012 Dutton Ridge, and 2012 North Junction plantings. Each planting utilized three-year-old seedlings from CRLA Parent trees grown by the DGRC. Seedlings are monumented with small metal tags inserted at ground level and mapped to ease relocation using a sub-meter accuracy Trimble GPS unit and ArcMap software. Seedlings are monitored annually for WPBR infection, vigor, growth, and damage as a joint effort between CRLA and the DGRC.

The 2009 Rim Village planting utilized an opportunity to restore the site of a former parking lot between the Rim Café and Gifts building and the Rim Village promenade. Three hundred and thirty-one seedlings were planted from 17 Resistant and Susceptible CRLA Parent trees. Susceptible seedlings were included in the restoration planting as a field validation of rust-resistance results determined by the DGRC. Since the planting site was a former parking lot, soils were highly compacted and a backhoe and auger were used to drill planting holes. Boulders, woody debris, and forest litter and duff were added to ameliorate the harshness of the planting site. Between one and three seedlings were placed in a planting hole. Seedlings were planted from September 15 – 23, 2009, and watered as needed until snowfall on October 1.

Figure 6. DGRC personnel assist with monitoring whitebark pine seedlings planted for restoration at the Horse Trail site. Photo by J. Beck.

The 2009 Horse Trail planting (Figure 6), located just south of Rim Village, is both a restoration project and an experiment to determine if inoculating seedlings with a beneficial fungal endophyte increases their chance of survival. Endophytes are fungal species that live inside plants and may confer benefits to their host such as resisting infection from WPBR. One hundred ninety-two seedlings were planted at the Horse Trail site from five Resistant and Susceptible CRLA Parent trees. One half of the seedlings were inoculated with the endophyte

Myrothecium roridum, the other half were treated with distilled water as controls. Seedlings were randomized and planted in five circular "family" (i.e., from the same Parent tree) plots; seedlings were planted one or two to a planting hole and seedlings with differing treatments were not planted in the same planting hole. No ameliorations were made to the site prior to planting. Seedlings were planted on September 28, 2009, and watered immediately after planting. It has not been confirmed if the inoculation of whitebark pine seedlings with *M. roridum* was successful; a graduate student is currently investigating this matter.

The 2012 Dutton Ridge and North Junction plantings were part of a FHP funded project involving CRLA, DGRC, the Deschutes National Forest, and Oregon State University. These two sites were selected due to their contrasting climatic regimes; North Junction (Figure 7) is located northwest of the Crater Lake caldera and Dutton Ridge is southeast of the caldera. Typically, the west side of the Park intercepts more precipitation from incoming Pacific storms than does the east side. Additionally, the North Junction site (2085 – 2103 m) is lower in elevation than the Dutton Ridge site (2195 – 2286 m). A total of 416 seedlings were planted at both sites. Seedlings originated from ten CRLA Parent trees; eight of these Parent trees were Resistant and two were Susceptible. The rationale for including Susceptible trees in the restoration planting is again to field-validate rust-resistance results determined by the DGRC. This project incorporated a randomized block design with the number of seedlings from each Parent tree divided as equally as possible among the blocks. Due to more area available for planting at Dutton Ridge vs. North Junction, five blocks were placed at Dutton Ridge with three blocks at North Junction. Fifty-two seedlings were assigned to each block. Seedlings were planted one to a planting hole, and planting hole locations were determined based on proximity to naturally occurring ameliorating microsite features such as downed wood and rocks. Seedlings were planted on October 18, 2012, and received no watering. Immediately after planting, the Park experienced a series of storms and received 27" of snow from October 19 – 25, 2012. In 2013, 130 naturally occurring whitebark pine seedlings of similar size to planted whitebark pine seedlings at the Dutton Ridge and North Junction sites were tagged, mapped, and assessed for height, vigor, WPBR

Figure 7. Planting whitebark pine seedlings for restoration at the North Junction planting site. Photo by J. Beck.

infection, and damage. These "natural regeneration" seedlings are included in the annual monitoring of this restoration project.

Results

Results are presented separately for each component of 2015 WPCP activities.

Collection Tree Monitoring

One hundred and one Collection trees were monitored in 2015, which encompasses all living Collection trees with confirmed locations (the location of tree CL27 remains unconfirmed). Two Collection trees died in 2015: CL14 ("D"-rated Susceptible tree) along the Rim Trail and WI01 ("C"-rated Resistant tree) on Wizard Island; both deaths were caused by WPBR. The Park has lost 7 of its 23 Resistant trees (26%), 6 due to MPB and 1 to WPBR; 5 out of 23 Susceptible trees (22%) have died (3 from MPB, 1 from WPBR, and 1 from unknown causes); and 1 Candidate tree out of 66 total (2%) has died from MPB (Figure 8). Rust-resistance screening results have been received from 46 Collection trees to date; results should be available soon for 2011 Collection trees (n = 27). Rust resistance at CRLA is promising so far with at least half of tested trees showing some degree of resistance (Figure 8), although sample sizes are small and more results will contribute to a better understanding of resistance and how it differs across the CRLA landscape.

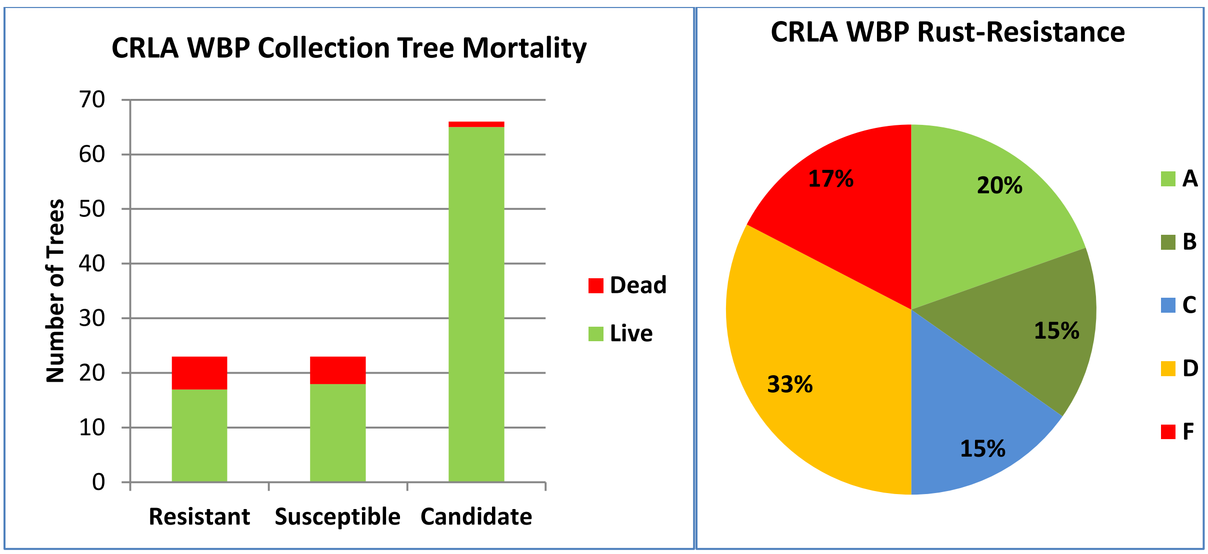

Figure 8. Collection tree mortality (left) and rust-resistance status for CRLA's whitebark pine (right).

Seven Collection trees initially selected for their phenotypic resistance to WPBR have since displayed disease symptoms; these trees are CL02 ("B" tree); RV01 ("D" tree); RV02 ("D" tree); RV03 ("C" tree); RV07 ("F" tree); RV09 ("D" tree); and WM04 (Candidate tree). Two Candidate trees infected with WPBR selected as controls for the rust-resistance screening process continue to display disease symptoms: CC10 and GC05. Three trees were lightly attacked (2-5 pitch tubes) by the MPB in fall 2014 but appeared healthy in 2015: CP02, MR02, and NJ05. All of these trees were treated with verbenone in early summer 2014, and attacked by MPB after pouches were in place.

Three trees (CW01, CW02, and WI02) continue to be afflicted with dwarf mistletoe (*Arceuthobium cyanocarpum*); tree CW01 appeared more heavily infested in 2015, and tree WI02 first exhibited aerial dwarf mistletoe shoots this year.

Verbenone Application

Verbenone was applied to 73 Resistant and Candidate trees from June 3 – 29, 2015. All trees had two pouches applied except for large-diameter trees NJ01 and NJ02, which had four pouches attached. No Collection trees succumbed to MPB attack this year, and with the exception of trees CP02, MR02, and NJ05, (which sustained a light attack as evident by 2-5 pitch tubes) all trees that had verbenone applied in 2014 appeared unaffected by MPB in 2015.

The MPB outbreak that has been impacting CRLA's whitebark pine since at least 2003 is still active, especially at the Park's highest elevations. While the annual MPB-caused mortality of whitebark pine is concerning, the cumulative impacts of over a decade of MPB attack have been devastating to the Park's whitebark pine communities. In an attempt to protect the Park's old, large-diameter whitebark pines from MPB-caused mortality, additional verbenone was obtained from the USFS FHP program. This allowed for the treatment of 108 "legacy" whitebark pines with verbenone in areas throughout the Park suffering the highest MPB activity (Figure 9). Funding has been requested from FHP to continue legacy whitebark pine verbenone application during the 2016 season. The 108 trees treated in 2015 will be assessed for MPB activity, mortality, and proximity to closest MPB-killed pine during the 2016 summer.

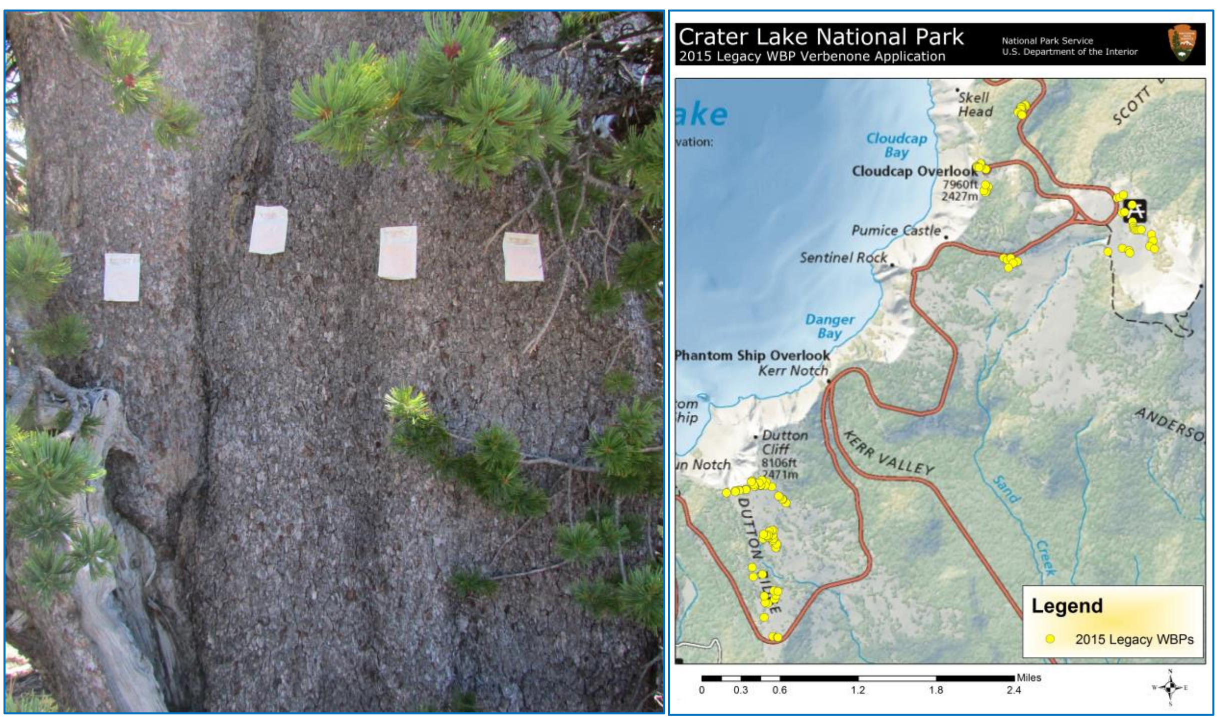

Figure 9. Legacy whitebark pine protected with verbenone (left); areas along East Rim Drive where verbenone was applied to legacy whitebark pines (right). Photo and map by J. Beck.

The Park uses Aerial Detection Survey (ADS) data provided by USFS Region 6 (Oregon and Washington) as an estimate of MPB activity on an annual basis (Figure 10). These data are not field-verified, and are used by the Park to detect rough trends in MPB activity. The 2015 ADS data show the MPB continuing to have an impact on forest health, including at the Park's highest elevations.

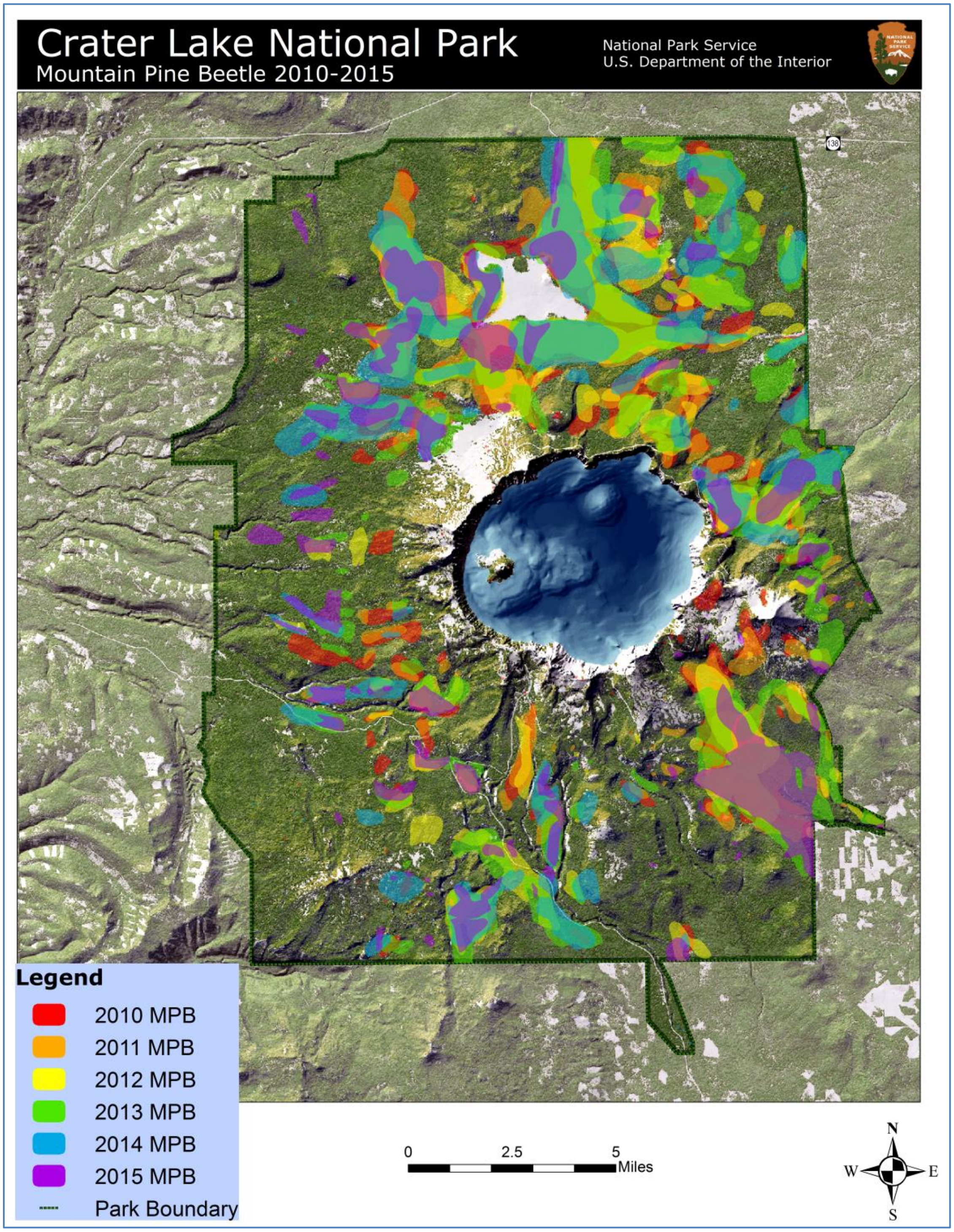

Figure 10. USFS ADS data for MPB activity within CRLA from 2010-2015. Map by J. Beck.

Long-Term Whitebark Pine Monitoring

The Park's seven long-term whitebark pine monitoring plots were sampled from August 24 – September 8, 2015. Recent MPB activity was observed at four of the plots: Mt. Scott (2536 m), Cloudcap (2442 m), Watchman (2425 m – Figure 11), and Llao Rock (2393 m). All plots continue to be impacted by WPBR; additionally, the Wizard Island plot continues to be devastated by dwarf mistletoe. Mortality of seedlings within plot areas in 2015 was caused by WPBR, animal predation, or drought/desiccation.

Figure 11. Long-term monitoring plot on the Watchman in 2015 with recent MPB-caused mortality. Photo by J. Beck.

Overstory whitebark pines (> 15 cm DBH) within plot areas have been reduced by 28.3% from 2003 to 2015; sapling whitebark pines (> 0 and < 15 cm DBH) have been reduced by 4.4% during this period. The MPB remains the leading mortality agent for overstory whitebark pine within plot areas. Mean blister rust infection of live whitebark pine has changed from 11.5% in 2003 to 29.0% in 2015. Average blister rust infection in live trees > 15 cm DBH has changed from 12.1% in 2003 to 36.7% in 2015.

Whitebark Pine Restoration Plantings

Figure 12. Whitebark pines planted for restoration at Rim Village during low-snow conditions when they are vulnerable to trampling. Photo by J. Beck.

The Park's four whitebark pine restoration plantings continued to do well three to six years after planting. Despite continued issues with visitor trampling (Figure 12), the Rim Village site continues to have the highest survival rate of any of the Park's four restoration planting sites. The 2015 survival rates for planted seedlings range from 73.4% to 87.9% and are displayed in Table 1. Data on survival of natural regeneration are also included in this table, as they provide some information on background mortality rates in naturally occurring whitebark pine seedlings.

Table 1. Survival rates for the Park's four whitebark pine restoration planting sites as of 2015. Natural whitebark pine regeneration was not monitored at Dutton Ridge and North Junction until 2013.

Site	2009	2010	2011	2012	2013	2014	2015
2009 Horse Trail planting	100.0	84.4	82.3	79.7	78.1	77.1	73.4
2009 Rim Village planting	100.0	97.0	91.5	91.2	90.9	89.7	87.9
2012 Dutton Ridge planting				100.0	88.8	78.5	73.8
2012 North Junction planting				100.0	89.1	80.8	73.7
Dutton Ridge Natural Regeneration					100.0	91.0	87.6
North Junction Natural Regeneration					100.0	93.6	93.6

Of the four planting sites, only five seedlings are confirmed to have died from blister rust with another suspected rust-caused death. These mortalities occurred at Rim Village (Figure 13) and the seedlings were progeny of C-F rated Parent trees (three seedlings, including the suspect one, from a "C" rated Parent tree; one seedling from a "D" rated Parent tree; and two seedlings from an "F" rated Parent tree). Ten seedlings at Rim Village were observed to be infected with blister rust in 2015; two of these seedlings are from an "A" rated Parent tree, one seedling is from a "B" rated Parent tree, two seedlings are from a "C" rated Parent tree, three seedlings are from a "D" rated Parent tree; and two seedlings are from a "F" rated Parent tree. The leading mortality cause of seedlings at Rim Village is herbivory. To date, no seedlings have been infected by blister rust at the Horse Trail site; most of the seedling mortality has been attributable to herbivory. At the Dutton Ridge site, four planted seedlings were observed to be infected with blister rust in 2015; three from "A" rated Parent trees and one from a "B" rated Parent tree. Four naturally occurring whitebark pine seedlings at the Dutton Ridge site were also observed to be infected with blister rust in 2015. No blister rust has been found on planted or naturally occurring whitebark pine seedlings at the North Junction site. The primary source of seedling mortality at

Figure 13. Inspecting blister rust-caused seedling mortality at the Rim Village planting site. Photo by J. Beck.

Dutton Ridge and North Junction sites (for planted and naturally occurring seedlings) has been herbivory and secondarily desiccation from drought.

Discussion

The 2015 season marked another year of efforts made by the Park to implement the CRLA Whitebark Pine Conservation Plan. While the Park continued to experience declines in whitebark pine populations due to mortality caused by MPB, WPBR, dwarf mistletoe, and other factors, efforts to conserve the species continued. The 2015 National Creek Complex of wildfires (Figure 14) burned through some confirmed and potential whitebark pine habitat in the areas of Desert Ridge, Klamath Ridge, Desert Cone, and Bald Crater; these areas will be surveyed in 2016 and impacts assessed.

Figure 14. The Crescent Fire of the 2015 National Creek Complex. Photo by J. Beck.

Planning continues for the Park's next round of whitebark pine restoration outplantings, scheduled for fall of 2016. This project will plant 480 whitebark pine seedlings from 16 CRLA parent trees for restoration and genetic conservation, and serve as a field trial to monitor future impacts of WPBR and the efficacy of genetic resistance. The process of gaining compliance with the National Environmental Preservation Act has been completed. The 2016 restoration planting will utilize an additional 84 whitebark pine seedlings from 15 CRLA parent families in a spot-planting restoration effort in addition to the field trial.

Additional work for the WPCP in 2016 will retain emphasis on Collection Tree Monitoring and verbenone application to all Resistant and Candidate trees; sampling the Park's seven long-term whitebark pine monitoring plots; and monitoring the Park's four whitebark pine restoration outplantings. Additionally, new Collection trees will be identified and cones collected from approximately 15 new phenotypically rust-resistant whitebark pines if funding is obtained to support extraction/stratification costs incurred by the DGRC. Assistance with cone caging and collection has been secured in 2016 from the Deschutes National Forest staff. Continued protection of legacy whitebark pines through verbenone application will be continued if funding to procure additional verbenone is approved by FHP.

Recommendations for WPCP work in the 2016 season include:

- Continue with verbenone application to legacy whitebark pines; monitor efficacy of 2015 treatments.

- Seek funding to procure 2017 verbenone as opportunities arise.
- Focus 2016 cone collections on unrepresented areas such as Timber Crater, Red Cone, Grouse Hill, and Union Peak.
- Continue to collaborate with the DGRC on monitoring health and status of whitebark pine restoration outplantings.
- Continue to update maps of seedlings planted for restoration annually.
- Complete the 2016 Restoration Plan for the upcoming whitebark pine restoration outplantings.
- Start planning for whitebark pine release treatments around rust-resistant trees and in areas with high probability of rust-resistance that are being threatened by non-whitebark pine conifer competition.
- Identify opportunities for fuels treatments in whitebark pine habitat in conjunction with Fire Management staff.
- Start planning for 2018-19 restoration outplanting and investigate whether rust-resistant whitebark pine seedlings sourced from warmer/drier locales may be available for planting.
- Work with the Interpretation and Maintenance staffs to better protect the restoration planting site at Rim Village and ensure its importance is communicated to Park visitors.
- Work with the Visitor Center planning team to ensure that whitebark pines are protected during construction and considered during revegetation efforts.

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December 2015